This resource assumes that you have a basic knowledge of what a percentage is and fraction/percentage/decimal correspondences. Here's a recap though!

35% m

?
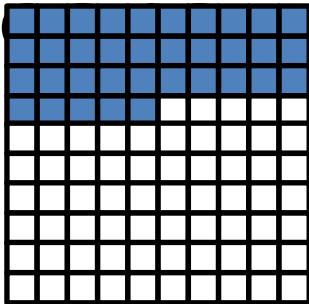
would like broccoli.

What is 35% as a

?

What is 35% of 8

?

problem from "*a percentage of an amount*" to "*a fraction of an amount*" is often easiest.

25% of 60
o?

20% of 45
?

30% of 40
?

Test Your
Understanding:

25% of 12   ?

75% of 24   ?

40% of 90   ?

20% of 60   ?

30% of 30   ?

5% of 80   ?

Another method is to find 10% or 1% and then building the desired percentage up:

35% of £64

10%:	**£6.40**
30%:	**£19.20**
5%:	**£3.20**
35%:	**£19.20 + £3.20 = £22.40**

x3   *÷2*   *x3*   *÷2*

10% means , so divide the total amount by 10 to find 10% to start with.

We need to get closer to 35%. To get to 30% we want 3 times more.

If we know 10%, then 5% would be half as much.

To make up 35% we want 30% + 5%.

65% of £26

10%:	**£2.60**
60%:	**£15.60**
5%:	**£1.30**
65%:	**£15.60 + £1.30 = £16.90**

Test Your Understanding

[Edexcel GCSE June 2004 1F Q12c, June 2004 3I Q5a]

There are 800 students at Prestfield School.

45% of these 800 students are girls.

Work out 45% of 800

🖉 [**?**]

[Edexcel GCSE Jun2016-1F Q16b]

The table gives some information about Charlie's spending last month.

Item	Percentage of total spending
rent	
food	15%
transport	12%
other	43%

If you finish…

Charlie's total spending last month was £800.

How much did Charlie spend on food last month?

🖉 £ [**?**]

Percentage Changes

Sometimes you have to find the value after a percentage increase or decrease.

I buy a phone on eBay for £40 and sell it on at a 30% profit. What do I sell it

?
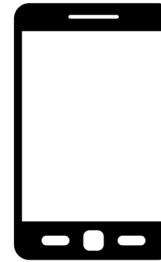
Test Your Understanding

Jim's pay is £180 each week.
Jim asks his boss for an increase of £20 a week.
Jim's boss offers him a 10% increase.

Find how much Jim will be paid with the increase offered by his boss.

£ [?] per week

In a sale, all normal prices are reduced by 20%

The normal price of a television set is 485 euros.
Work out the sale price of the television set.

[?] euros

1 Using converting the percentages first into fractions, determine the following:

a ? b ?
c 10% of 12 = **?** d 25% of 16 = **?**
e 30% of 20 = **6** f 40% of 25 = **?0**
g 75% of 48 = **?3?** h 60% of 140 = **?34**

90% of 50 = **45**   12.5% of 32 = **4**

2 By working with multiples of 10%/5% or otherwise, determine the following:

a ? b ?
c ? d ?
e 15% of 40 = **?** f 35% of 60 = **21**

65% of 120 = **78** 45% of 30 = **13.5**

3 17.5% of 80 = **14** 8% of 300 = **24**

a By any suitable method determine
b the following values after the
c percentage change:
d 40 after an increase of **?** = **42**
e 60 after a decrease of 2**?** = **48**
f 50 after an increase of 2**?** = **62.5**

24 after a decrease of 75% = **6**
35 after an increase of 60% = **56**
25 after a decrease of 40% = **15**

4 *[OCR GCSE June 2013 1F Q20a, June 2013 3H Q4a]* On weekdays it costs £6.50 per hour to hire a tennis court at Meadway Tennis Club. On Saturdays the cost is 30% more. How much does it cost to hire [?]t for 2 hours on a Saturday?
£16.90

5 *[Edexcel GCSE June 2017 1F Q19, June 2017 1H Q2]* Bill buys and sells laptops. Last month Bill bought 50 laptops. He paid £400 for each laptop.
He sold 40 of these laptops at a profit of 30% on each laptop and 10 of these laptops at a profit of 15% on each laptop.
[?]ast month was to sell all 50 laptops for a total of at least £25 000. Did Bill reach this target?
£25400 so yes.

6 *[Edexcel GCSE Nov2014-1H Q11]* Ria is going to buy a caravan. The total cost of the caravan is £7000 plus VAT at 20%. Ria [?]it of £3000.
She pays the rest of the total cost in 6 equal monthly payments. Work out the

You have 5 friends. 2 of them have a Netflix subscription. What fraction is this?

NETFLIX

NETFLIX

$$\frac{2}{5}$$
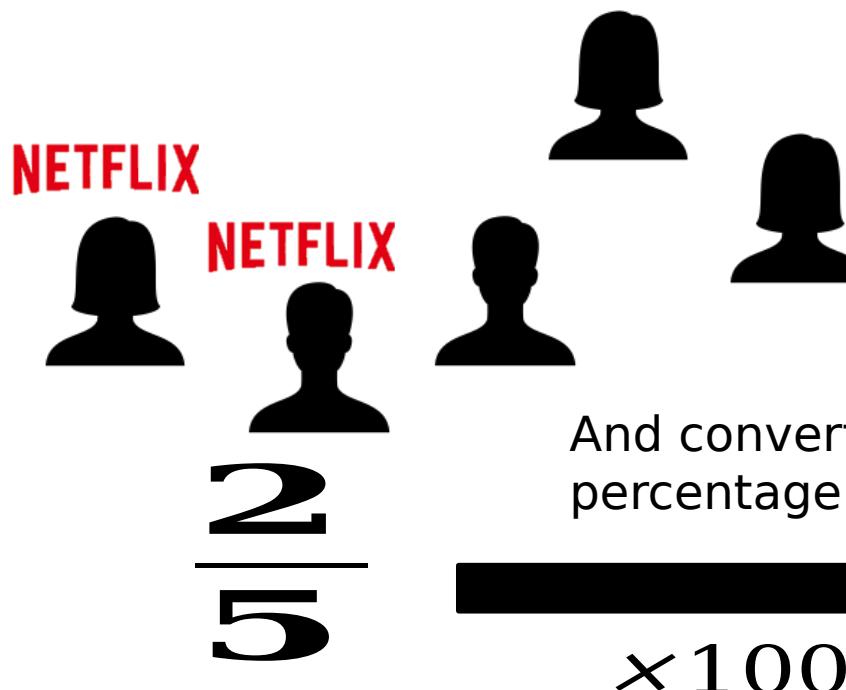
And convert this to a percentage…

$\times 100$

40%

! To find what percentage one amount is of another, find what fraction it is, then convert to a percentage.

Further Examples

What is £11 as a
percentage of £57?

?

e

[OCR GCSE(9-1) Nov 2017 2F Q12a]

Jack carries out a survey in his school.
He selects 50 students, at random, and asks them

Do you think that it is a good idea to have women-only railway carriages?

These are his results.

	Number of students
Yes	32
No	13
Don't know	5

What percentage of the students in Jack's survey answered 'Yes'?

$$\frac{32}{50} \qquad \qquad 4\%$$

?

Percentage Change

To work out a percentage change, consider the change as a fraction of the **original amount**.

My YouTube video views of "cat playing with box" increased from 12 to 18.

Actual

?

Change as a fraction of original

?

As a

?

! Percentage change

Further Example

Sales in Tiffin ties declined from 420 in last year to 360. What percentage drop is that?

?

The price of gold per kg increases from £2100 to £2300. What is the

?

1 What is:

a 4 as a percentage of 20: [?]
b 10 as a percentage of 50: [?]
c 27 as a percentage of 30: [?]
d 57 as a percentage of 60: [?]
e 24 as a percentage of 60: [?]
f 36 as a percentage of 45: [?]
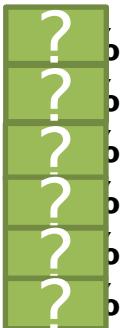
2 What is the percentage change from:

a [?]
b 40 to 60: [?] se
c 50 to 30: [?] se
d 75 to 90: [?] se
e 40 to 28: [?] se
  80 to 68   **15% decrease**
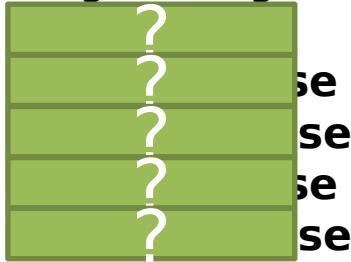
3

[OCR GCSE(9-1) Nov 2017 1F
[?]

Write 62 as a percentage of 500.
4 **12.4%**

[?]

The price of a cat falls from £40 to
5 £15. What percentage change is
this? **62.5% fall**

[?]

Frost Co's annual profits increase

6 *[Edexcel GCSE Nov2013-2H Q10 Edited]*
Sasha takes a music exam. The table
shows the result that Sasha can get for
different percentages in her music exam.
Sasha gets 62 out of 80 [?] usic
exam
Wha [?] t

Percentage	Result
50% – 69%	Pass
70% – 84%	Merit
85% – 100%	Distinction

7 [KS3 SATs 2001 L6-L8 Paper 2 Q12a]
The table shows the average weekly
earnings for men and women in 1956
and 1998.
For 1956, calculate the average
weekly earnings for women as a
percentage of the average weekly
[?] for men.
Give your answer to 1 decimal place.
51.8%

	1956	1998
Men	£11.89	£420.30
Women	£6.16	£303.70

8 [KS3 SATs 2003 L6-L8 Paper 2 Q11a]
A cup of coffee costs £1.75
The diagram shows how much money different people get when you buy a cup of coffee. Show what percentage of the cost of a cup of

?

Retailers get 44p
Growers get 5p

Cup of coffee costs **£1.75**

Others get £1.26

Not drawn accurately

9 [Edexcel IGCSE May2014-3H Q12a]
Helen's savings increased from £155 to £167.40. Work out the percentage increase in He ?
savings. **8%**

[OCR GCSE June 2013 4H Q2]
The price of a car increases from £10 400 to £11 284. Calculate the percentage increase.

?

[OCR GCSE(9-1) Practice set 1 5H Q5]
Kamile sells sandwiches. In May, she sold 400 sandwiches. In June, Kamile sold 20% more sandwiches than in May. In July, Kamile sold 15% fewer sandwiches than in June.
? e the percentage change in her sales from May to July.
2%

**1
2**

[IMC] A shop advertised "Everything half price in our sale", but also now advertises that there is "An additional 15% off sale prices". Overall, this is equivalent to what reduction on the ?   rices?

?

57.5%

2

[IMC] Inspector Remorse had a difficult year in 2004. A crime wave in Camford meant that he had 20% more cases to solve than in 2003, but his success rate dropped. In 2003, he solved 80% of his cases, but in 2004 he solved only 60% of them. What was the percentage ?   ne number of cases he solved in 2004 compared with 2003?

?

2

Down by 10%

[STMC] In a sale, the price of a computer is reduced by 20%. At this reduced price the shopkeeper still ?   fit of 20%. What would have been his percentage profit if the computer had been sold at full price?

?

Decimal Multipliers

$$25\% \text{ of } 12$$
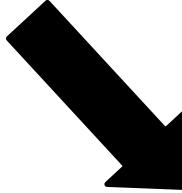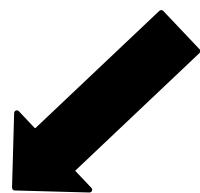
$$\frac{1}{4} \times 12 \qquad 0.25 \times 12$$

Earlier we saw we could convert the percentage into a fraction (and 'of' into)

...but we could also turn it into a decimal.

The 0.25 is known as a **decimal multiplier**, and multiplying by it has the effect of finding 25% of something.

Suppose we wanted to find 100% of £14. What would we multiply it by?

?

What if we wanted to find 80% of it?

?

80% as a decimal is 0.8. This *feels* rights, because multiplying by a number just less than 1 makes the number just slightly smaller, which we expect.

What if we wanted to increase it by

?

Everything starts at 100%. So if it increases by 10%, it's now at 110%. This is 1.1 as a decimal.
This *feels* right as multiplying by 1.1 slightly increases a number.

Reduce it by 15%?

?

Everything starts at 100%. So if it decreases by 15%, it's now at 85%. This *feels* right as multiplying by 0.85 is a bit less than 1 so slightly decreases the number.

Quickfire Questions

Effect	Multiplier
No change	?
Find 15% of it.	?
	?
Find 3% of it.	?
Increase by 10%	?
	?
Decrease by 30%	?
	?
Increase by 3%	?
Decrease by 4%	
Increase by	

A common student error is to use rather than . Be very careful with single digit increases/decreases.

Check Your Understanding

Show the calculation needed (using only a single multiplication)

a Find 38% of £4.20

b Find 70% of £35

c £60 after an increase of 12%

d £85 after an increase of 7%

e £3.20 after a decrease of 12%

f £8.24 after a decrease of 1%

g N £10 after an increase of 10%
    followed by a decrease of 10%

?
?
?
?
?
?
?

1 By using decimal multipliers, calculate the following, giving your answer to the nearest penny/cent: (and showing the multiplication you use)

a 13% of £56   **£7.28**

b 74% of £3.20   **£2.37**

c 130% of £77.10   **£10**

d 31% of £8.41   **£2.61**

e 1.5% of £75   **£1.13**

f £80 after an increase of 20%

g £35 after a decrease of 10%

h £46 after an increase of 2%

i £103 after a decrease of 30%   **0**

j £70 after an increase of 5.5%   **5**

k $840 after an increase of 125%   **$1890**

? ? ? ? ? ? ? ? ? ? ?

2

Pippin the Cat initially weighs 10kg. She gets 10% heavier one year, followed by 20% heavier the next year. Felix the Cat again initially weighs 10kg. She gets 15% heavier one

?

Who is the heaviest after the two years?

3 [Kangaroo Grey 2004 Q7] Maija has a rectangular patio in her garden. She decides to make the patio larger by increasing both its length and width by 10%. What is the

? increase in the area of the patio? **21%**

[Edexcel GCSE June 2013] The normal price of a television is reduced by 30% in a sale. The sale price of the television is £350. Work out the normal price of the television.

What makes this problem different?
We're trying to find the value <u>before</u> the percentage change.

$$\text{Original price} \quad \xrightarrow{\times 0.7} \quad £350$$
$$\xleftarrow{\div 0.7}$$

From the previous lesson, we know that we could reduce something by 30% by multiplying it by 0.7. This gives us a new value of £350.

…We could therefore retrieve the original value by dividing by 0.7.

But wait...

[Edexcel GCSE June 2013] The normal price of a television is reduced by 30% in a sale. The sale price of the television is £350. Work out the normal price of the television.

"If the value reduced by 30% to £350, can't we just add 30% back on to £350 to get the original value?"

Explain why Misguided Mike is wrong.

?

is not the same as the original amount.

[Edexcel GCSE June 2013] The normal price of a television is reduced by 30% in a sale. The sale price of the television is £350. Work out the normal price of the television.

Method 1:

?

[Edexcel GCSE June 2013] The normal price of a television is reduced by 30% in a sale. The sale price of the television is £350. Work out the normal price of the television.

Method 2:

?

Class Poll: Which method do you prefer?

Further Examples

[Edexcel GCSE Nov 2013] In a sale normal prices are reduced by 20%. A washing machine has a sale price of £464. By how much money is the normal price of the washing mac~~reduced?~~

Ensure you re-read the final sentence of the question!

?

[Edexcel IGCSE May2013(R)-4H Q5aii] A shop, *Furniture 4U*, had a sale. In the sale, normal prices were reduced by 15%. The normal price of a chair was reduced in the sale by $24.
~~Work out the normal price of the chair.~~

?

We could have also used

Test Your Understanding

My take home salary after 20% tax is £24000. What is my full

?

[Edexcel GCSE Nov2006-4I Q14b, Nov2006-6H Q6a] The price of all rail season tickets to London increased by 4%.
The price of a rail season ticket from Cambridge to London increased by

?

1 In a sale all the prices are reduced by 25%. The sale price of a dress is £30. Work out the normal price of the dress.

?

2 The price of a new television set is £480. This price included VAT at 20%. Work out the cost of the television set before VAT was added.

?

3 A holiday is advertised at a price of £403. This represents a 35% saving on the brochure price. Work out the brochure price of the holiday.

?

4 [Edexcel IGCSE May2016-4H Q3b] In a sale, all normal prices are reduced by 20%. In the sale, the price of a tablet computer is reduced by. Work out the normal price of the tablet computer.

395 euros

Continued on next slide

5 A large firm hires 3% more workers which brings its total number of workers to 12772. How many workers did the firm originally have?

?

6 Tasha invests some money in a bank account. Interest is paid at a rate of 8% per annum. After 1 year there is £29 in the account. How much money did Tasha invest.

?

7 [Edexcel GCSE June 2017 2F Q23, June 2017 2H Q2] 30% of the people at a concert are female. 1295 of the people at the concert are male. Work out the number of people at the concert who

?

555 people

Exercise 4

8 *[Edexcel IGCSE May2016(R)-3H Q5b]* In a sale, normal prices are reduced by 8%. In the sale, the price of a shirt decreases by £3. Work out the n̲ ? price of the shirt. **£37.50**

9 After a 26% pay rise, Bob is earning £44,100. W̲ ? before the pay rise ?

10 The Harribear population increases by 23% one year to 4182 Harribears. How many bea ?
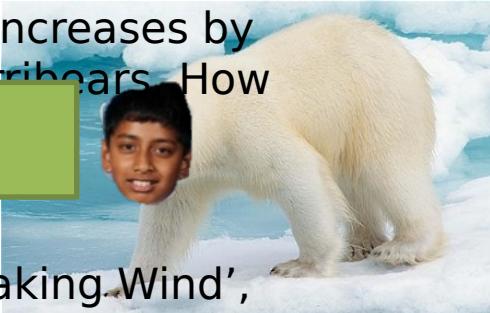
11 In the series finale of 'Breaking Wind', ratings were up 125% from last year's season finale. 10.5 million people watched this year. How many people ?

12 *[OCR GCSE(9-1) Nov 2017 5H Q7]* Naomi is given a 10% pay decrease. Her new wage is £252 per week. W̲ ? wa̲ ? received a 10% pay increase?

13 *[IMC 2008 Q11] What is ?* ?

S is 25% of 60

60 is 80% of U

80 is M% of 25

14 *[JMO 1996 A7] When a barrel is 30% empty it contains 30 litres more than when it is 30% full. How many litres does the* ̲ ̲ hen full? **75**

Exercise 4

N [TMC Regional 2013 Q7] A shopkeeper paid £30 (cost price) for a coat. She wishes to place a price tag on it so that she can offer a 10% discount on the price marked on the tag and still make a profit of 20% on the cost ? rice should the tag?

Solution: £40

N [JMO 2001 A6] 'One third of the population now has access to the internet; this is 50% more than one year ago.'
What fraction of the population had ? internet one year ago?

Solution:

N [SMC 2007 Q9] In a sale, a shopkeeper reduced the advertised selling price of a dress by 20%. This resulted in a profit of 4% over the cost price of the dress. What percentage profit would the shopkeeper have made if the dress

?

Compound Changes

Sometimes we have to consider multiple percentage changes one after another.

My house is worth £750,000. However, due to an economic crisis, the value depreciates by 10% each year. How much is it worth 3 years later?

The decimal multiplier for a 10% decrease is 0.9.
We multiply by 0.9 to get the value after the first year.

$$750\,000 \times 0.9 \times 0.9 \times 0.9$$

$$¿\,750\,000 \times 0.9^3$$

$$¿\,546\,750$$

We can simply multiply by 0.9 again to apply the decrease again. We do so a third time for the third year.

We can write this calculation more concisely using a power.

! Value after multiple applications of a percentage change:

where is the multiplier representing the percentage change and is the number of times to apply it.

Further Examples

I put £1000 into an account with 3% interest per annum. How much is there in the account after 7 years?

Side Notes: "Bank interest" is the percentage your money saved goes up by each year – the idea is that banks can use your money to make more money, e.g. through loans to other people, so they reward you for saving with them. "Per annum" means per year.

?

In Bickerbank, you receive 1% interest p.a. in the first year and 5% in each subsequent year. If I save £250, how much do I have after 6 years?

?

I put £1000 into an account with 3% interest per annum. How much is there in the account after 7 years?

A common student error is this:

3% of £1000 is £30.
This means I earn £30 per year:

What went wrong?

?

With **compound interest**:

Quickfire Compound Changes

State the calculation you would require for the following (final value not needed)

Question	Calculation required
1 The value of a car after 4 years if its initial value is £8000 and it falls in value by 20% each year.	?
2 The height of a child after 6 years if he starts at 70cm tall and grows by 5% each year.	?
3 My bank balance at 15 years if I initially save £5600 and get 2.5% interest p.a.	?
4 The number of stamps in my collection after 10 years if I start with 60 stamps, and increase my collection by 30% in the first year and 20% in each subsequent year.	?

1 *Edexcel GCSE June 2004 4I Q24a, June 2004 6H Q12a]*

A company bought a van that had a value of £12 000

Each year the value of the van depreciates by 25%.

Work£ ? e years.

Vocab: "depreciate" means reduce in value.

2 *[Edexcel GCSE June 2017 2H Q14]*

Jack has £15 000 to invest in a savings account for 3 years. He finds information about two savings accounts. Jack wants to have as much money as possible in his savings account at the end of the 3 years. Which of these two savings accounts should

Simple	Compound
Simple interest	Compound interest
2.3% each year	2.15% each year

?

So far we've dealt with compound change questions where we're calculating the new value after multiple changes.

$$original \times d^n = new$$

But it could be the original value that is unknown (i.e. a "*reverse percentage*" question):

"I invest some money. After 3 years with 50% interest, I have £3375. What did I originally invest?"

Or the number of years/months could be unknown...

"I put £1000 into a bank account with 10% interest. After how many years will the amount I have reach above £2000?"

Or even the multiplier could be unknown...

"I put £1000 into a bank account. After 3 years, with compound interest, I have £1500. What percentage interest did I get each year?"

Type 1: Reverse Compound Change

The key for all three types of these questions is to just use the usual formula.

I invest some money. After 3 years with 50% interest, I have £3375. What did I originally invest?

?

The population of polar pears decreased 10% each year for 5 years, before dropping to 23620 bears. How many

?

The key for all three types of these questions is to just use the usual formula.

I put £1000 into a bank account with 10% interest. After how many years will the amount I have reach above

?

6-6H Q17] Gwen bought a new car. Each year, the value of her car depreciated by 9%. Calculate the number of years after which the value of h

Note: You're not even given the value of the car! Any value (e.g. £10 000) will do.

?

Type 3: Unknown percentage change

The key for all three types of these questions is to just use the usual formula.

"I put £1000 into a bank account. After 4 years, with compound interest, I have £1500. What percentage interest did I get each year?"

?

Note: You can't just divide the 50% overall increase by 4 (i.e. the answer is not 12.5% per year). The amount the account value rises by each year is not the same.

Test Your Understanding

[Edexcel GCSE (9-1) Mock Set 1 Autumn 2016 3H Q14]
The number of fish in a lake decreases by % each year. Given that the number of fish halves in 8 years, work out the value of . Give your answer correct to 1 decimal place.

?

Hint 1: You aren't given a starting number of fish. Just start with any simple number.
Hint 2: As with the example above, find the decimal multipler first, and then convert this into the percentage .

1 £1000 is invested for 2 years at 5% per annum with compound interest. Work out the total amount in the account after 2 years. **?**

2 A motorbike is worth £6500. Each year the value of the motorbike decreases by 35%. Work o~~ut~~ **?** ~~at the~~ end of t~~he three years.~~

3 A house is worth £175000. Its value increases by 6% each year. Work out the **?** ~~ars.~~ Give your answers to the nearest pound.

4 b) **£208428**   b) **£313398**   c) **£751077** **?**

5 The population of giraffes decline from 4000 by 15% each year. After how many years will the population be less than half? **5 years** **?**

6 You have £1000 to save. Bank Frost offers 2% interest on your savings in the first year followed by 4% the second. Bank Cheeseright offers 3% both years. Which bank would be **?** **Cheeseright better.**

7 [Edexcel GCSE Nov2014-2H Q14] Peter has £20000 to invest in a savings account for 2 years. He finds

Bonus Saver

Compound interest

4% for the first year then 1.5% each year

Fixed Rate

Compound interest

2.5% each year

Peter wants to have as much money as possible in his savings account at

?

8 [Edexcel GCSE(9-1) Nov 2017 2H Q13b] At the beginning of 2009 the value of a company was £250000. In 6 years the value of this company increased to £325000. This is equivalent to an increase of % each year. Find the value of .
Giv... sign...

?

9 [Edexcel GCSE June2009-4H Q19b] Jaspir invested £2400 for years in a savings account. He was paid 7.5% per annum compound interest. At the end of the years he had £3445.51 in the savings account.
...value of .

?

10 Cheryl's savings increase by 40% for 3 years until she has £65856. How much did she star...

?

11 Each day Tarquin ate 25% of his chocolates. After 4 days he had 1620 chocolates left. How many chocolates did he initia...

?

12 [Edexcel GCSE(9-1) Mock Set 2 Spring 2017 1H Q10] Here are three rectangles.
The area of rectangle is 10% greater than the area of rectangle .
The area of rectangle CC is 10% greater than the area of rectangle . By what percent... is the area of rectangle gr... rectangle ?

| A | B | C |

?

So 21% greater

Exercise 5

12
Across 10 years, a bagel triples in value. Presuming compound increases, what is the percentage

?

So 11.6% increase each year.

13
[Edexcel GCSE(9-1) June 2017 3H Q10]
Naoby invests £6000 for 5 years. The investment gets compound interest of % per annum.
At the end of 5 years the investment

?

i.e. 6%

2
One year shares in NeogiCorp increase by 10%. The year after they increase by 20%. What is the average percentage

?

and 20, while 15 would be the arithmetic mean.

3
I save £100. A bank account offers 5% interest p.a. Given

?

year? (Assume a year is 366 days)